Electric freight vehicles in city logistics

insights into decision making process of frontrunner companies

Altenburg, M.; Anand, N.R.; Balm, S.H.; Ploos van Amstel, W.

Publication date
2017
Document Version
Other version
Published in
European Battery, Hybrid and Fuel Cell Electric Vehicle Congress

European Battery, Hybrid and Fuel Cell Electric Vehicle Congress
Geneva, 14th - 16th March 2017

Electric freight vehicles in city logistics: Insights into decision-making process of frontrunner companies.

Altenburg M.[1], Anand N.[2], Balm S.H. [2], Ploos van Amstel W. [2]
[1]*Martijn Altenburg (corresponding author) Amsterdam University of Applied Sciences, Weesperzijde 190 1097 DZ Amsterdam The Netherlands, M.Altenburg@hva.nl*
[2] *Amsterdam University of Applied Sciences*

Abstract

To achieve emission reduction targets and to improve local air quality of cities, the uptake of Electric Freight Vehicles (EFV) is essential. Knowledge concerning why companies do adopt EFV is lacking. Research about the diffusion of innovations and the market of EFV shows that frontrunner companies with an innovative or early adopting mindset are adopting (or willing to adopt) EFV. Increase in demand of EFV by such companies can help take a step forward towards mass production of EFV and eventually reduction in purchase cost of EFV. The main objective of this paper is to get insights into the decision-making attributes of frontrunner companies. A qualitative approach was used and 14 interviews were conducted among frontrunner companies delivering goods in the city of Amsterdam. Results show that innovators and early adopters are all motivated by socially or environmentally positive effects of EFV. Strategic motives played a role for all companies who already adopted EFV. All companies wanted to adopt EFV but technical limitations, due special requirements for the goods transported, are a reason to not adopt EFV. Getting insights into the preferences of frontrunner companies, the (local) authorities can adjust their policy, schemes and sustainability campaigns to attract more companies adopting EFV. Manufacturing companies can use the insights from this research to adapt their vehicle technology to answer needs of the potential customer for faster adoption rate.

Keywords: Electric Freight Vehicles, City logistics, Urban logistics, sustainable transport

1 Introduction

The IPCC [1] noted that to avoid potentially catastrophic environmental, social, and economic consequences from climate change, there needs to be substantial decreases in CO2 emissions, specifically in energy production and the transport sector [2]. The "Roadmap to a single European transport area" addresses CO2 emissions of the transport sector and sets objectives for transport in Europe [3] [4]. In addition to the exclusion of all 'conventionally fueled' cars by 2050, the roadmap sets a specific ambition for city logistics. City logistics should be essentially CO2-free in major city centers by 2030. Substituting a conventionally fueled vehicle with an electrical vehicle helps reducing CO2 emissions and is therefore widely considered as the solution to reduce CO2 emissions in city logistics. Cities also adopt electric vehicles as measure to reduce local air pollution. While vans and trucks represent approximately 10% of total national fleets [5], they are responsible for about 70% of the road transport related NOx concentrations affecting the urban air quality in cities [6]. Poor air quality is a pressing problem in many urban areas as it affects the health of people and as a result reduces the life expectancy of citizens [7]. To achieve the GHG emission reduction targets and to improve local air quality of cities, cleaning of freight vehicles seems crucial.
Despite many incentive programs from local and national authorities and improvements in the technology of electric freight vehicles, companies are reluctant to abandon their conventional vehicles and switch to electrical freight vehicles. This reluctance is despite electric freight vehicles

(henceforth EFV) fit the requirements of city logistics perfectly [8]. The market share of EFV among vans and trucks in the Netherlands is only 0.1% [5] and its growth in the last years is not promising when compared to personal electric cars [6]. To make a clear distinction between EV and EFV from now on in this paper EV is about personal electric vehicles and EFV is about electric freight vehicles.

As the uptake of EFV is crucial for local authorities it is essential to know what drives adoption of EFV by companies. Previous studies on EFV mainly focused on evaluating the technical aspects and business case behind the adoption of EFV [6]. These studies conclude that EFV is not a directly interchangeable alternative for conventional vehicles, mainly because of the limited range EFV offers and the longer charging time needed to get the maximum range [8]. EFV's higher costs are mainly due to the fact that EFV is not mass produced, which makes it harder to develop a good business case for companies in city logistics because total cost of ownership are higher than conventional vehicles [7]. The higher costs makes the threshold for adoption of EFV higher since the overall competitiveness of EFV is lower than conventional vehicles [6], [9], [10]. Mass production should lower the price of EFV and increase competitiveness of EFV [7]. The lower price and increased competitiveness will increase adoption. Therefore local authorities and car industries' first priority should be to develop higher market demand for EFV to achieve enough demand for mass production. To create higher demand for EFV it is essential to know what drives adoption of EFV by companies in logistics. Innovation theory suggests adoption motives differ for different moments in time in the adoption process. Therefore adopting companies also differ for different moments in the adoption process [11]. Since market share of EFV within the Netherlands is only 0.1%, this study focusses on frontrunner companies.

The main objective of this paper is to get insights into the decision-making attributes of frontrunner companies in logistics. First different innovation theories are described and compared to the current market of EFV. Then data obtained from interviews with different frontrunner companies are described. The remaining part of this paper focusses on main motives to adopt EV and other important attributes that contributed to the adoption of EV. Finally some actions are suggested to increase the uptake of EFV.

2 Literature and theoretical framework

2.1 Diffusion of innovation

The main models of innovation diffusion were established in 1970 [12]. Modelling developments in the period 1970 onwards have been modifying the existing models by adding greater flexibility in various ways. Despite a large number of research projects, only a few questions have been finally resolved and therefore no single theory is established as the leading theory on diffusion of innovation.

The main theories (and most relevant) were developed by Mansfield [13], Rogers [11] and Bass [14]. All agree on the S-shaped curve for cumulative adoption of an innovation (as shown in Figure 1). Examination of datasets suggests that the S-shaped type of model is generally appropriate for the diffusion of innovation [12]. Explanations in to why the line is S-shaped are different. Bass [14] and Mansfield [13] base their theories on the dynamics of a (broadly) homogeneous population, while Rogers [11] based his theory on the heterogeneity of the population. Rogers describes the differences in adoption of an innovation in time. The theory described that consumers or companies adopt an innovation in different moments in time. The time dimension is crucial for the understanding of the adoption process since it 1) acknowledges that the diffusion process is not just happening in one moment and it 2) acknowledges that the different moments in time also mean different market conditions, social contexts and a different (more technical advanced) product [15]. Bass [14] and Mansfield [13] both describe more of an imitation phenomenon where individuals or companies are influenced by a desire to innovate and by a need to imitate others in the population. Both theories assumes a static product which does not acknowledge the development and market conditions of the product [15]. Looking at the market of EFV the acknowledgment of development of EFV and changing market conditions seem crucial to the adoption rate of EFV and therefore the theories of Bass [14] and Mansfield [13] seem less appropriate to apply.

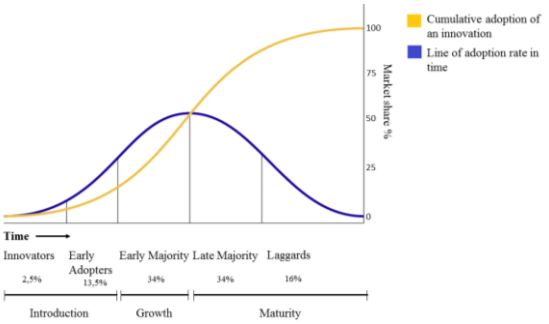

Figure1: Adoption rate in time and cumulative adoption based on Rogers [11]

Rogers [11] describes the differences in adoption of an innovation in time and the development of the product and its market conditions. Rogers assumes that consumers have different preferences to the innovation itself and the market conditions surrounding it. As the innovation develops and market conditions change the innovation fits the preferences of different groups of consumers. For example; a more secure person would like to buy a certainty and will wait until the innovation is more developed and successfully proven in practice, while an adventurous person prefers to buy an innovation as soon as he can to stand out of the crowd. Therefore the more secure person will adopt the product later and the adventurous person will adopt as soon as possible. So different consumers have different moments in time to adopt an innovation, since the product fits better to their preferences [11].

Rogers distinguished five different groups, seen in Figure 1; Innovators, Early adopters; Early majority; Late majority and Laggards [11]. Innovators are the first to adopt an innovation. Followed by the early adopters who are the first to successfully apply the innovation. Then early and late majority follow who adopt after mass production is achieved and finally the laggards are last to adopt the innovation. The percentages used in Figure 1 for each group are based on the normal distribution (e.g. innovators are two standard deviations or more above the mean level of innovativeness) [12]. There is however no empirical evidence for the normal distribution Rogers used. But one can argue that this theory is not about the specific "cut off points" of when a specific group of adopters starts and the other group ends. For example; the middle ages were a specific period in time from 500 until 1500. However this time period can only be ascribed afterwards. It is not as if people in 513 said they were 13 years in to the middle ages. The "cut off point" where the middle ages start could only be decided afterwards. Besides strict lines are not really applicable to different time periods. The year 501 was not really different to the year 500 or the year 499. The same can be said about the five different groups Rogers distinguished. If the process of diffusion is still going on it is hard to establish which specific group of adopters is in play; especially in the phase of innovators and early adopters. Only afterwards the precise "cut off points" between groups can be specified. Therefore Rogers proposed that the adopter categories were to be used primarily for descriptive and planning purposes [12]. Rogers also proposed that identifying the adopter categories could provide a strong basis from which to design and implement intervention strategies aimed at particular groups of individuals [16]. This research aim is to establish the decision-making attributes of frontrunner companies of EFV. Knowledge on the decision-making attributes helps to set up effective interventions that stimulate further adoption of EFV.

Bočkarjova et al. [15] combined the S-shaped form of adoption in the theory of Rogers with three phases in the S-shaped adoption of marketing research. Marketing research defined three phases: introduction, growth and maturity (as shown in Figure 1). During the introduction phase the innovation is tested by innovators and early adopters. If successful the early majority will adopt the innovation and the innovation moves into the growth phase in which mass production is achieved [15]. As Bočkarjova et al [15] describe, based on Rogers innovation theory, in the introduction phase EFV will be used by innovators and early adopters. Innovators adopt an innovation as the very first. Innovators are adventurous and well informed consumers. Innovators have sufficient resources and are willing to take risks by adopting an innovation as the very first. The second group, early adopters, are the first to implement an innovation successfully and are considered so by late adopters. Early adopters are highly educated opinion leaders; they see the importance of future solutions of the new technology and want to be the first to profit from it [15].

Innovators and early adopters show many similarities. Innovators and early adopters are less inclined to be influenced by high uncertainty, high costs or the lack of competitive advantage in their choice of a new innovation [15]. This description of the innovation, innovators and early adopters adopt, is similar to the state of the current EFVs. Recent state of the art studies show that the overall competitiveness of EFV is lower and costs are

higher than conventional vehicles, but EFV can be successfully implemented in city logistics [8]. Also both innovators and early adopters adopt an innovation before mass production has been achieved [15]. As argued above during the process of diffusion it is hard to establish which specific group of adopters is in play. However since mass production is not yet active it seems safe to say that the growth phase has not yet been reached. Also market share suggests EFV is in the introduction phase of innovation since only 0,1% of vans and trucks is electric [5]. We can establish that at this stage demand for EFV is still to be expected from innovators and early adopters. For this research early adopters and innovators are also called frontrunners.

2.2 EFV/EV research

There is extensive research on consumers as potential users of EV [9], [17]–[19]. There is however very little research that focuses on companies as potential user of EV or EFV [6]. As a result little is known about the motives why companies adopt EFV or EV or why they do not.

An early study on EV adoption revealed that motives why companies adopt EV were a need for a vehicle that would fit the company's travel needs, an environmental-friendly mode of transport, more affordable fleet vehicles and fuel savings [20]. This study was focused on Neighborhood Electric Vehicles (NEV). Neighborhood electric vehicles is a U.S. denomination for smaller vehicles with a low top speed (40 km/h). They are also called Light Electric Vehicles (LEV).
Sierzchula [2] looked into factors influencing fleet managers' adoption of EVs. In 14 interviews with fleet managers testing new technologies was reported as being the dominant driver of the initial adoption of EVs. Secondary factors included lowering environmental impact, government grants, and improving the organization's public image. Research by Rolim et al [21] gathered data among 25 users of EVs over a period of a year. Among these 25 users 13 were private users and 12 were driving cars from the company fleet. They concluded that private users have different motives to adopt EVs. Some fleet managers mention the company's image as the motive behind the deployment of EVs in fleets, but the majority of fleet managers mention environmental factors as the main motive. Private users indicate that environmental and economic (lower running costs) factors are the main drivers for EV adoption [21]. While both studies focus on companies, both did not include freight vehicles.

When looking at research among EV adoption behavior of consumers some interesting results stand out. Krause et al [22] found that there is a misconception among consumers on the costs and range of electric vehicles. The misconception is problematic because it is influencing interests in EV [22]. Accurate knowledge is therefore likely to be an important condition for purchasing EV since knowledge of public incentives and the advantageous aspects of EV is crucial in adoption of EV [22]. It is interesting to explore whether the misconception about costs and range also exists within companies regarding EFVs and whether knowledge about public incentives and regulations is correct.

One study among consumers in the Netherlands [23] concluded that the probability of adopting EV is mostly determined by symbolic attributes of electric vehicles. The influence of symbolic attributes is even higher when consumers see instrumental (technical, range, price) disadvantages. This effect does not show for advantages. Symbolic attributes reflect aspects of an electric vehicle that contributes to the identity or social status of a person or company. By acquiring a product the consumer or company is able to create his or her image or confirm his identity. Hereby we usually prefer to create an image that reflects how we see ourselves or how we want others to see ourselves [23]. For example; someone viewing himself as a sustainable person can buy an electric car to confirm for himself that he is sustainable. Or a person can think it is important that others see him as sustainable, so he buys an electric car so that others view him as sustainable and thereby confirming his image. In this research companies will be asked about their identity and whether image plays a part in the decision to adopt EFV. Keizer et al [23] noted that the influence of symbolic attributes were not found if respondents were asked directly if symbolic attributes played a part in the decision to adopt EV. Respondents gave socially desirable answers. Although companies are far more forthcoming about how they create their own image, socially desirable answers will be accounted for by analyzing results as a whole to see if the identity described is confirmed.

3 Research approach

The objective of this paper is to get insights into the decision-making attributes of frontrunner companies. As seen in the literature little is known about the decision-making process of companies to

adopt EFV. Therefore data collection was done by interviews. Interviews are a good way to explore a particular topic, get in-depth knowledge and to explore a topic.

3.1 Respondents

To get insights about the decision-making reasoning of frontrunners 14 interviews were conducted. Respondents were contacted through a network of frontrunner companies within the city of Amsterdam. All respondents were members of this network of frontrunner companies in zero emission city logistics. Out of 14 interviewees, eight companies have already adopted EFV where as six are interested in purchasing EFV to carry out logistics activities. Five out of the six companies that do not drive EFV, did however adopt other innovative solutions to reduce pollution from transport (e.g. solar panel charged refrigerating systems or alternative fuels). Table 1 shows the distribution of the 14 companies interviewed by different characteristics.

As seen in Table 1 companies of three different sectors were interviewed. Five companies from the food sector, four from construction logistics and five in the services sector. Companies were classified in sectors on the basis of the goods they deliver. All companies' area of delivery included the city of Amsterdam. For three companies Amsterdam was the only area where they offer their services or goods. Four companies offer their goods nationwide; none of these companies are in services. The other seven companies offer their services or goods regionally. Company size ranged from 19 to 2000 employees and fleet size ranged from 1 van to 600 vans or trucks. The two bigger companies (fleet and employee wise), were companies who delivered their goods nationwide. All companies have their own fleet, although three companies hire external transport for the majority of their deliveries and three companies hired external transport for a small part of their deliveries. The companies that hire for a minority of their deliveries did so to be flexible during times when fewer deliveries were needed, for example during holiday season. Companies that hire external transport for the majority of the deliveries also have their own fleet to be able to deliver backorders or to be able to adopt an innovative solution as sustainable as possible. None of the companies in services hired external transport.

3.2 Data collection and analysis

Figure2: Process of collecting, preparing and analyzing of the data

Data collection included a questionnaire and an interview. Respondents were asked to fill out a short self-reported questionnaire before conducting the interview. The main objective of this questionnaire is to test if there is a misconception in the knowledge of EFV and whether knowledge about consequences of conventional vehicles and public incentives and regulations is correct. The questionnaire contained seven statements and three open questions. Statements had three possible answers; true, false or don't know. An example of the statements used is 'The municipality of Amsterdam offers a subsidy of 5000 Euro for electric vehicles'. An example of an open question used is 'The range of an electric van is maximum of …. km'. Three statements and the three open questions were about the EFV market, two statements were about consequences of conventional vehicles and two statements were regarding current policy of the municipality of Amsterdam.

Analysis of the questionnaire was done by checking the answers and judged, based on current knowledge from literature, either correct or incorrect. Statements with the answer "don't know" where not judged. Open questions were not judged as incorrect and could only be judged correct. Misconception in knowledge about the EFV market was only defined when at least two statements about the EFV market were ruled incorrect.

Table1: Distribution of the 14 companies

Employees		**Fleet**		**Sector**		**Area of delivery**	
0-25	5	1-10	7	Food	5	City of Amsterdam	3
25-100	3	10-100	5	Construction	4	Regional	7
100-250	4	>100	2	Services	5	National	4
>250	2						

The interviews were conducted in a semi-structured format. A list of questions was developed containing seven topics of conversation:

- Interests for EFV
- Conditions for adopting EFV
- Use of EFV
- Policy/subsidies
- Company
- Customers
- Employees

The interviews were conducted face-to-face. The list of questions was used to facilitate and guide the conversation with the interviewee. Interviews lasted an average of 44 minutes with the longest being 56 minutes and the shortest being 33 minutes. Interviews were recorded and then transcribed , step 2 in Figure 2. Respondents were given the option to review the transcripts of the interviews. Two respondents reviewed their transcripts, however no alterations were made.

3.3 Coding

The transcriptions were used for analyzing the data; the last step in Figure 2. Analysis was done by coding. Coding is a process in which you tag or label a chunk of data, in this case phrases, sentences, or paragraphs of the conversation, relevant to the research. Not all the text needs to be coded as can be seen in the example below.

Example of coding from one of the interviews: "Let me think, what was crucial to go electric? Well yeah, It is a lot of things together actually. On one side it is emotion, then there is business and what I mean with emotion is, I am very in favor of clean air. There are young boys who seriously suffer from asthma. I just believe that something has to be done to get it cleaner, that it needs to happen fast. Thus that is one thing that counts. *On the other side, business, I see the possibilities to distinguish yourself.*"

In the example the underlined and italic sentences are codes. Only the lines that are relevant to the research are coded. Codes can be theory driven, in which case codes are developed before coding the interview starts. Codes can also emerge from the raw data, which is called data-driven [24]. In this case a data driven approach, specifically open coding, was used to code all interviews. Coding was done in MAXQDA, a software tool for coding. An average of 51 codes per interview was given with a maximum of 86 and a minimum of 38.

Codings of two interviews then were reviewed by fellow researchers to assure coding was done correctly and codes were interpreted the same way. Based on comments from the reviews all interviews then were recoded. In the end the code tree contained 16 maincodes and 79 subcodes. A maincode was used to label the subject matter, then a subcode was used to label the content. In the example above both codes have of the maincode 'Motives to adopt EFV' which is the subject matter of the codes. The subcodes are different because the content of the codes are different. The underlined piece has the subcode 'clean air' and the *italic piece* has the subcode 'company strategic'.

MAXQDA was used to interpret the results. This was done by viewing all subcodes belonging to one maincode. For example, the maincode 'Motives to adopt EFV' was selected to see all subcodes which belonged to 'Motives to adopt EFV'. This way motives to adopt EFV mentioned in all interviews and the number of times a reason was mentioned could be viewed easily. Also MAXQDA was used to combine codes to find correlations.

4 RESULTS

Of the 14 companies interviewed, eight companies are already using EFV. When comparing the main characteristics (as used in Table 1) to whether or not a company adopted EFV, a few things need mentioning. Of the companies interviewed only one out of four companies in construction adopted EFV, three out of five food companies adopted EFV and four out of five companies in services adopted EFV. Fleet size and the area of delivery mattered in the choice for EFV for one company. The company only had one vehicle for deliveries, while delivering regionally. Therefore the range of EFV was not sufficient. No other correlations where found.

Respondents filled out the questionnaire before the interview started. All statements regarding the consequences (i.e. negative environmental impact) of conventional vehicles were filled out correctly, only one statement was answered 'don't know'. The results of the questionnaire suggest that respondents were largely aware of the consequences of conventional vehicles. When looking at policy, more respondents reported to be unaware about current policy to increase the uptake of EFV, although still most of the answers (15 out of 28 total answers) were filled out correctly. One respondent stands out with two false statements regarding current policy. This respondent was 1 of 2 respondents who had two false answers regarding statements of the EFV market and was perceived as having a misconception towards EFV. This was

confirmed in the interview. The company of the respondent adopted an electri c truck fairly early in the development of electric trucks. As usual with very early adoption of an innovation, many initial technical issues arise. These initial technical issues need fixing and since EFV is a new innovation, repairs can take longer than normal. The initial technical issues causes the vehicle to be inoperable for unknown periods of time. When a company is not prepared for the uncertainties that follow due to initial technical issues there is a mismatch in expectations. The mismatch in expectations causes frustrations. These frustrations influenced the respondents' attitude towards EFV in a negative way. Although the respondent was aware of the development of electric vans, the respondent still had a negative attitude towards EFV. The other respondent who was perceived as having a misconception towards EFV filled in the questionnaire with EFV vehicles with 'refrigeration' in mind as the respondent works in the food sector. In general respondents were very aware of the EFV market or were aware about their lack of knowledge about EFV. 11 respondents were able to name at least one brand of electric vans and eight respondents had no false answers. The general knowledge of EFVs confirms the companies' interests in EFV and fits the profile of innovators and early adopters as described by Bočkarjova et al [15].

4.1 Motives and conditions for adopting EFV

When looking at companies who adopted EFV it needs to be noted that in every company there is a combination of motives (not one) that supported in the decision to adopt an EFV. Also crucial conditions for the adoption of EFV were mentioned. The conditions that need to be met to adopt EFV and motives behind the adoption were related. Also sometimes crucial conditions were mentioned as a motive to adopt EFV. In the next few paragraphs both motives and conditions will be discussed.

In the interviews eight different motives for the adoption of EFV were mentioned (see Table 2). Two motives stand out as they were mentioned by every company driving EFV. The first reason is companies were motivated to take their social or environmental responsibility to society. Specifically motivated by the need for better air quality, making the city more livable or reducing CO2 emissions. This was internally motivated and part of the identity of companies. In the words of one respondent: "*The passion in our company is there. That has to do with the job we do; because we want to make Amsterdam more secure, but also cleaner. And those are two words that clang around these walls* [within the company building] *every day. And that is really what our company stands for, so yes. Socially concerned, yes.*"

A second reason all companies noted was strategic motives for the company. These strategic motives

Table2: Motives, conditions and adjustments mentioned by companies driving EFV

Motives (nr/total EFV users)	**Conditions for adoption**	**Adjustments to EFV**
Social or environmental responsibility (8/8)	Business case around breakeven point (6/8)	Alterations in logistics (8/8) • Route planning (5/8) • Using HUB (2/8) • Extra cars (1/8)
Strategic motives (8/8) • Future driven (5/8) • Distinctive character (4/8) • Business opportunity (1/8) • Adjust to expected future regulations (1/8)	Devotion to EFV (5/8)	EFV driving course (3/8)
Improving image (6/8)	Good location (2/8)	More efficiency to compensate higher costs (2/8)
"Just do it" (emotional) (4/8)	Warranty on battery's (1/8)	
Customer expectations (2/8)	Service range of company needs to fit range EFV (1/8)	
Advantage in Tender (1/8)	Learn from other EFV experiences (1/8)	
Loading & unloading easier (1/8)		
Financial advantages (1/8)		

differed for companies (as seen in Table 2). Companies saw new business opportunities or were looking at expectations for the future and therefore wanted to be among the first to drive EFV. This also has to do with environmental motives but is more externally motivated. As one respondent put it; "… *so just looking at the future of course. I go a long way in Amsterdam and I know that we have to keep the city livable and there is only one way to do that.*" The respondent explains there is only one way to keep Amsterdam livable and that is by driving electric. Electric driving is therefore perceived as the inevitable future of the company and therefore it is important to adopt EFV. One company also saw new business opportunities in using EFV.

A third reason came up when looking at the identities described by the companies who adopted EFV. The sustainable and socially concerned nature of five companies stood out. These companies also take other actions that contributes to a sustainable society; for example, procuring green energy or not using paper. The other three companies who adopted EFV stood out because of a more innovative nature. Both types of companies, the ones who described themselves as having an innovative identity and the ones who described themselves as having a sustainable identity, reported their identity played an important part in the decision to adopt EFV. One respondent explained; "*When I call our company innovative, that means that you cannot be the last in the row to wait on what happens. No, than you try to be a frontrunner and that means that sometimes things can costs more to try it and test it.*" The innovative and sustainable identity is also reflected in two motives to adopt EFV mentioned before.

Six respondents also reported that improving the image of the company and being able to use it for marketing purposes was a reason to adopt EFV. On the other hand three respondents reported that improving the image played no role at all, as they were afraid of a phenomenon called greenwashing (meaning misleading consumers about the company's environmental performance or the environmental benefits of a product or service [25]). Here is also a clear connection with the identity of the company. One respondent could not be proud about only driving 50% electric and therefore would not use it marketing wise. Another respondent said that it is so natural to them to take their corporate social responsibility that "…. *you are not going to put on a website that all your employees do not run red lights? It is in the same category for us. It is so natural to us*."

Four out of eight companies driving EFV also reported a 'just do it' mentality. It became clear that the companies differ in their operationalization of this mentality. A number of companies see it as a way of identification, a way separate themselves as a company from competitors. Other companies interpret this more as taking a risk/trusting their gut; not doing all the math beforehand. The respondents did not make a total rational decision to adopt EFV. One respondent explained "…. *And then you are in the situation to buy an electric truck. Just pure emotions. There is no ratio behind it, we did it but it was a really weird decision*."

As mentioned before there were several conditions for companies that are important to the successful adoption EFV. One of these conditions, mentioned by six respondents, is that the business case of EFV should be around the breakeven point. One respondent reported this as a reason to adopt EFV. "*Crucial was that the business case showed that it would not be very negative. It would be just a little negative, if you do it right, if you do it smart; it would not be very negative. That was the consideration to do it, because you naturally show that you are doing it green, which is nice for our customers, but also for the city of Amsterdam. Because we as a company want to deliver in cities in a green way. And that is the drive that is behind it.*" This citation shows that the respondent reports an almost even business case as a reason but then immediately says that it was more a condition that needed to be met to make green transport in cities achievable.

In the same citation, the respondent also mentions that in order to make the business case around even 'you need to do it smart'. This leads to an adjustment companies had to make, mentioned in all interviews with companies. In order to drive EFV the company needs to make alterations in their logistics to overcome barriers caused by limitations of EFV such as evening out the business case or to adopt to the range of EFVs. Companies do this in different ways. Five companies made alterations in their routes and planning, two companies use a hub and one company purchased two extra cars so that drivers can switch vehicles during their routes. These alterations also show an effort of employees and the company as a whole is needed to be able to drive EFV. Five respondents mentioned the devotion to the adoption of EFV as an important condition. " *There is a lot involved and you need to fully devote yourself to driving electric. And not*

think 'this does not work' because otherwise you fall through."

Respondents reported positive experiences driving EFV. Also employees were positive about EFV. Most companies driving EFV experienced a learning curve in the adoption of EFV and sometimes there was an initial threshold among employees. Similar results were found in several other studies on EFV [8], [26], [27]. Three out of eight companies driving EFV reported their drivers took up a special course for driving EFV. All three companies indicated the course as a crucial requirement in the success of adoption of EFV and in overcoming the initial threshold. The importance of a EFV driving course is also found in the latest state of the art on EFV [8]. One company reported they had severely less damage costs since driving EFV, because drivers learned to drive calmly to keep the range of the vehicle as large as possible. The lower damage costs were an unexpected advantage.

4.2 Barriers in adopting EFV (reasons not to adopt EFV)

Of the 14 companies interviewed six did not adopt EFV. All companies, who did not adopt EFV, also wanted to adopt EFV. Five respondents interviewed indicated that they were retained from adopting EFV because of technical restrictions which currently apply to EFV. These restrictions consist of not fitting the conditions or for the physical specifics of the freight of the companies. For transporting food often refrigerating is needed and there are currently no electric vans available with refrigeration. Construction materials differ in size and materials in the early process of construction are either big or heavy. Big materials which simply do not fit in an electric van or heavy materials who significantly decrease the range of an electric vehicle and therefore are not yet transportable by EFV. The companies in food who did adopt EFV delivered food for which no cooling is needed. One bigger company is currently in a pilot with one prototype electric truck with cooling powered by an alternate source. The one construction company driving EFV delivers smaller lighter objects wherefore no technical restrictions apply. The other company that not adopted EFV had a bad experience trying out an electric vehicle five years ago. As reported the past technical problems experienced resulted in a negative valuation of EFVs that still determines their opinion of EFV. As EFV was not available for food for which refrigeration is needed or heavy construction materials, five out of six companies adopted other alternatives to deliver as sustainable as possible. These alternatives where either using a solar panel powered refrigeration system (2), using biogas as dual fuel (2) or by using a hub in which construction materials are consolidated and prepared for the construction site (1).

4.3 Other influencing factors

When asked about other influencing factors respondents rarely mention parking privileges or subsidies as crucial in the decision making process. Such benefits were mentioned as helpful and stimulating by all companies driving EFV: "…. *to start the experiment (with EFV) more easily, we used the subsidy available by the municipality of Amsterdam.*" Privileges, such as being able to park where it is usually forbidden, were perceived as more of a reward for making the leap towards EFV then it was perceived as a difference maker in adopting EFV. "*I have always said, we as companies stuck our necks out. It costs more, it takes lots of time and energy. Give us something in return*." As the citation shows privileges are seen as a reward for making the leap towards EFV. Two respondents also noted that without privileges a diesel van would be able to do the same as an electric van, which makes no sense to them as the government wants to stimulate EFV. Subsidies or parking privileges were also not mentioned as something governments should do to increase adoption as these measures were not perceived as crucial in the decision making process.

Of 14 respondents 13 indicated that they felt no external pressure from society, customers or the government to adopt EFV. The one respondent who felt pressure indicated that the pressure had to do with the depreciation period of trucks. The municipality of Amsterdam has the aim to have (as much as possible of the) city logistics zero emission in 2025. The depreciation period the company uses is nine years in which (at the time we spoke) it will be 2025. So for every non electric truck they buy after 2016, there are a few years of the deprecation period that it could be the truck becomes useless. This pressure of the deprecation period is not yet there for vans, since the deprecation of vans is shorter but this pressure will eventually come for vans as well. While measures as subsidies, privileges and the environmental zone (an area in the city center of Amsterdam were vans constructed before 2003 are not allowed) did not create pressure to adopt EFV, all these measures were perceived as helpful and stimulating. The combination of all measures creates a stimulating culture around

Amsterdam. As one respondent put it; "*And if, and that is not pressure, but if you hear something about electric driving than it is always about Amsterdam*."

When asked what should be done to increase adoption of EFV in general eight respondents (including some who currently do not use EFV) asked for stricter rules in the city center. For example; "…*create a clear framework. Just start with you can enter the city center until eleven, unless you drive electric." And "I think that it will go that direction, that it is closed for cars who pollute. That you can just enter the city with electric vehicles. You can find my enthusiasm for that.*" According to these respondents, stricter rules would make the uptake of EFV easier and would increase the demand of EFV. It needs to be noted that companies who already drive EFV will benefit from stricter rules in favor of EFV. Of eight respondents in favor of stricter rules three respondents did not adopt EFV, so even among companies who did not yet adopt EFV there are those in favor of stricter rules.

5 Conclusion

To achieve the GHG emission reduction targets and to improve local air quality of cities, cleaning freight vehicles is crucial. To increase the uptake of EFV it is essential to know what drives adoption of EFV by companies. Research in to the diffusion of innovations shows adoption is to be expected of innovators and early adopters. To get insights about the decision-making reasoning of early adopters 14 interviews were conducted.

Results show early adopters are all motivated by socially or environmentally positive effects of EFV. Strategic motives played a role for all companies who already adopted EFV, in a way that EFV is perceived by a number of respondents as the inevitable future of city logistics and therefore companies wanted to adopt early. The identity of companies who adopted EFV was important in the decision to adopt EFV. Identities were described as either sustainably/socially concerned or innovative. Other motives mentioned were improving the image of the company and a 'just do it' mentality that was mentioned in half of the interviews with companies driving EFV. Technical limitations, due to special requirements for the goods transported, are a barrier in adopting EFV. These limitations especially apply to companies in food logistics and construction logistics. Furthermore parking privileges, subsidies and other stimulating policies are rarely mentioned as crucial in the decision making process. Such benefits were, nonetheless, perceived as helpful and stimulating. Interestingly many respondents (including some who currently do not use EFV) vouched for stricter rules in the city center. According to them, stricter rules would make the uptake of EFV easier and would increase the demand of EFV.

6 Discussion

It needs to be noted that these results are just a first glimpse in to the decision making process of early adopters. Although strong results were found, the small sample size needs to be taken in to consideration. As these results are based on 14 interviews further research is needed to establish the motives for adopting EFV among innovators and early adopters. This research enables future research to do a survey among a larger sample size including non-frontrunners. The result found that companies who adopted EFV have a sustainable or innovative identity needs further research. Right now the direction of causality is not certain. The identity of companies could have changed into sustainable or innovative after adopting EFV. Conclusions are based on research among innovators and early adopters. Motives for adoption among early and late majority may be very different to motives found in this research. When the uptake of EFV is achieved and mass production of EFV will start, research in to the decision making process of early and late majority could be helpful. Finally this research was carried out in the Netherlands. Sustainability and social concerns could be very different in other cultures and therefore motives to adopt EFV could differ. Results can probably be more easily extrapolated to countries with similar cultures to the Netherlands. Research in cities in other (for example Mediterranean) cultures is needed to confirm or deny these differences.

Policy makers often introduce financial incentives, supportive measures and pilot projects to leverage the use of clean technology – e.g. EFV. Such policies are often based on the technical and economical attributes. While these policies are helpful lowering the threshold for adoption of EFV, they are not specifically targeting early adopters. Currently research mainly focusses on the technical and economic aspects of using EFV. Information about these aspects are helpful for understanding the conditions and to overcome barriers to successfully adopt EFV and could be crucial for early and late majority. However, these aspects are less relevant in the decision-making process of innovators and early adopters. This study shows that for innovators and early adopters the sustainability

and innovation power of EFV is crucial to adopt EFV. This is also reflected in their identities. Therefore we assume that policy and marketing campaigns could be more effective in changing behavior of the stakeholders if the campaigns also focus on symbolic attributes– e.g. green company, socially responsible firm, being innovative - instead of solely focusing on instrumental aspects of EFV. Governments and municipalities are recommended to aim their efforts towards companies with a sustainable or innovative identity to increase the uptake of EFV.

Acknowledgments

We would like to thank Robert van den Hoed for his contribution to this research. Support from KennisDC logistiek (Dutch centre of knowledge for logistics) for funding this research is greatly acknowledged.

References

[1] IPCC, "RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION," 2012.

[2] W. Sierzchula, "*Factors influencing fleet manager adoption of electric vehicles*," Transp. Res. Part D Transp. Environ., vol. 31, pp. 126–134, 2014.

[3] EC, "*Roadmap to a Single European Transport Area*," Brussel, 2011.

[4] EC, "*A European Strategy for Low-Emission Mobility*," 2016.

[5] BOVAG RAI, "*Mobiliteit-in-Cijfers-Auto-2015-webversie.pdf*," 2015. [Online]. Available: http://bovagrai.info/auto/2015/media/Mobiliteit-in-Cijfers-Auto-2015-webversie.pdf. [Accessed: 11-Mar-2016].

[6] S. Balm, J. Spoelstra, and H. Quak, "*Applying a behavioral change model to the adoption of freight electric vehicles : lessons for effective instruments*," pp. 1–13, 2014.

[7] H. Quak, N. Nesterova, and T. van Rooijen, "*Possibilities and Barriers for Using Electric-powered Vehicles in City Logistics Practice*," Transp. Res. Procedia, vol. 12, pp. 157–169, 2016.

[8] N. Nesterova and H. Quak, "*Validating Freight Electric Vehicles in Urban Europe D1 . 3 addendum 1 : State of the art of the electric freight*," no. 321622, pp. 0–44, 2015.

[9] O. Egbue and S. Long, "*Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions*," Energy Policy, vol. 48, no. 2012, pp. 717–729, 2012.

[10] W. Sierzchula, S. Bakker, K. Maat, and B. Van Wee, "*The influence of financial incentives and other socio-economic factors on electric vehicle adoption*," Energy Policy, vol. 68, pp. 183–194, 2014.

[11] E. M. Rogers, *Diffusion of Innovations*, 4th Edition. 2010.

[12] N. Meade and T. Islam, "*Modelling and forecasting the diffusion of innovation - A 25-year review*," Int. J. Forecast., vol. 22, no. 3, pp. 519–545, 2006.

[13] E. Mansfield, "*Technical Change and the Rate of Imitation*," Econometrica, vol. 29, no. 4, p. 741, Oct. 1961.

[14] F. M. Bass, "*A New Product Growth for Model Consumer Durables*," http://dx.doi.org/10.1287/mnsc.15.5.215, 1969.

[15] M. Bočkarjova, J. Knockaert, P. Rietveld, and L. Steg, "*De (toe)komst van elektrische auto's in Nederland*," Tijdschr. Vervoer., vol. 51, no. 2, pp. 40–67, 2015.

[16] B. Oldenburg and K. Glanz, "*Diffusion of innovations*," in Health Behavior and Health Education: Theory, Research, and Practice, Jossey-Bass Inc, 2008, pp. 313–333.

[17] C. Barbarossa, S. C. Beckmann, P. De Pelsmacker, I. Moons, and W. Gwozdz, "*A self-identity based model of electric car adoption intention: A cross-cultural comparative study*," J. Environ. Psychol., vol. 42, pp. 149–160, Jun. 2015.

[18] M. Barth, P. Jugert, and I. Fritsche, "*Still underdetected – Social norms and collective efficacy predict the acceptance of electric vehicles in Germany*," Transp. Res. Part F Traffic Psychol. Behav., vol. 37, pp. 64–77, Feb. 2016.

[19] A. Hackbarth and R. Madlener, "*Willingness-to-pay for alternative fuel vehicle characteristics: A stated choice study for Germany*," Transp. Res. Part A Policy Pract., vol. 85, pp. 89–111, Mar. 2016.

[20] Green Car institute, "*Study of NEV User Behavior in California*," 2003. .

[21] C. C. Rolim, P. C. Baptista, T. L. Farias, and O. Rodrigues, "*Electric vehicle adopters in Lisbon: motivation, utilization patterns and environmental impacts*," Eur. J. Transp. Infrastruct. Res., vol. 14, no. 3, pp. 229–243, 2014.

[22] R. M. Krause, S. R. Carley, B. W. Lane, and J. D. Graham, "*Perception and reality: Public knowledge of plug-in electric vehicles in 21 U.S. cities,*" Energy Policy, vol. 63, pp. 433–440, Dec. 2013.

[23] K. Keizer, E. H. Noppers, and L. Steg, "*De onderschatte rol van symbolische attributen in de adoptie van elektrische auto's - De onderschatte rol van symbolische attributen in de adoptie van elektri....pdf*," Tijdschr. Vervoer., vol. 51, no. 2, pp. 25–39, 2015.

[24] J. T. DeCuir-Gunby, P. L. Marshall, and A. W. McCulloch, "*Developing and using a codebook for the analysis of interview data: An example from a professional development research project*," Field methods, vol. 23, no. 2, pp. 136–155, 2011.

[25] M. A. Delmas and V. C. Burbano, "*the Drivers of Greenwashing*," Calif. Manage. Rev., vol. 54, no. 1, pp. 1–38, 2011.

[26] H. J. Quak, "*Improving Urban Freight Transport Sustainability by Carriers – Best Practices from The Netherlands and the EU Project CityLog*," Procedia - Soc. Behav. Sci., vol. 39, pp. 158–171, 2012.

[27] T. Taefi, J. Kreutzfeldt, T. Held, R. Konings, R. Kotter, S. Lilley, H. Baster, N. Green, M. S. Laugesen, S. Jacobsson, M. Borgqvist, and C. Nyquist, "*Comparative Analysis of European examples of Freight Electric Vehicles Schemes. A systematic case study approach with examples from Denmark, Germany, The Netherlands, Sweden and the UK,*" in 4th International Conference on Dynamics in Logistics - LDIC 2014, 2014.